Arkwin, A Disease-Resistant Oat *and* Comparisons of Small Grains as Winter Forage

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CONTENTS

Cover Picture

Shown on the cover is a single panicle of Arkwin at full maturity.

Agricultural Experiment Station, University of Arkansas College of Agriculture. Lippert S. Ellis, director; Dwight Isely, associate director. Main Station, University; with Cotton Branch Station, Lee County; Rice Branch Station, Arkansas County; Fruit and Truck Branch Station, Hempstead County; and Livestock and Forestry Branch Station, Independence County.

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By H. R. Rosen, W. J. Wiser, and J. O. York[1]

Arkwin, a variety of fall-sown oats bred at the Main Station, was released in 1952 by the Arkansas Agricultural Experiment Station. It is highly resistant to Helminthosporium blight, as well as to a number of other important diseases.

Since the appearance of Helminthosporium blight on oats in Arkansas about 1945, there has been an increasing need for oat varieties that are resistant to this disease and that can be depended upon to produce good fall and winter pasture as well as good grain yields.

Such varieties as Stanton, Victorgrain, Fulgrain, and DeSoto are all highly susceptible to this disease, and Traveler is in part susceptible. Yet these varieties are among those commonly used for winter pasture and for grain. When they are sown early in the fall, as they should be wherever good winter pasture is desired, Helminthosporium blight often causes so much reduction in stand that adequate fall and winter grazing is not obtained.

The Red Rustproofs, including Ferguson 922, Appler, Nortex, New Nortex, Nortex 107, Hastings Hundred Bushel, and Delta Red, are resistant to the blight, but they produce relatively small foliage and are so prostrate in habit of growth that they do not yield adequate amounts of winter pasture. In addition, none of the Red Rustproofs possess much winter hardiness, and all are likely to be killed in winters when the weather is severe.

This bulletin describes Arkwin and presents its record up to and including 1952. Likewise, because of the increasing use of small grains for winter grazing in Arkansas, information is presented on the protein content and forage values of Arkwin and other small grain varieties.

ORIGIN OF ARKWIN

Parentage

Arkwin represents a selection from a cross made by H. R. Rosen and L. M. Weetman at the Main Agricultural Experiment Station greenhouses in Fayetteville in the winter of 1936-37. The parents of this cross are Tennessee 1922 and Bond-Iogold. Ten-

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nessee 1922, used as the pistillate parent, is an exceptionally winter-hardy oat. It is one of a number of selections made by N. I. Hancock of the Tennessee Agricultural Experiment Station from Winter Fulghum C. I. 2499, which is now known as the variety Pentagon. Tennessee 1922 has somewhat better straw than three named sister selections Tennex, Forkedeer, and Fulwin. Unfortunately, all four selections are so susceptible to common races of crown rust and smut that their forage and grain yields are frequently unsatisfactory despite their remarkable winter hardiness.

The pollen parent of Arkwin, Bond-Iogold (Iowa 4097), represents a selection from a cross made by H. C. Murphy of the United States Department of Agriculture, working at Iowa State College. This selection is a typical spring oat with practically no winter hardiness but possessing a high degree of resistance to a number of common races of crown rust, to common races of smut, and to some races of stem rust.

The primary objective of crossing Tennessee 1922 with Bond-Iogold was to attempt to combine the winter hardiness of the former with the disease resistance and upright habit of growth of the latter. This appears to have been accomplished in the variety Arkwin.

Generations in Which Selections Were Made

The first selections from the cross Tennessee 1922 x Bond-Iogold were made in the F_2 generation. Progeny from the F_1 were subjected to artificial inoculations with crown rust and smut in the greenhouse, and to both artificial and natural epidemics under field conditions. In 1938, F_2 plants that were found to be resistant to both diseases were saved and all susceptible ones were discarded. The same processes were duplicated in the F_3 and F_4 generations (1939 and 1940) with both artificial and natural epidemics of crown rust and smut, the reselections being chosen only from plants that showed resistance. The selections were in the form of single plants or single panicles, with the greatest number being single plants. This was made possible by space-seeding. Emphasis was placed on single plant rather than single panicle selections, on the assumption that such a practice was more likely to reveal selections that possessed a greater range of disease resistance including resistance to adverse soil or weather conditions as well as to parasitic root, leaf, stem, and panicle diseases.

By selecting single plants with the greatest disease resistance there appeared to be almost simultaneous selection for vigor and for good forage and grain yields.

Up to and including the F_4, all the inoculum of crown rust used included races 1, 7, and 16. These constituted the races commonly found in Arkansas at that time. Since 1936 the senior author has conducted a survey each year in all the important oat-growing counties in the state and gathered rust and smut collections in each county where rust or smut was present. There were very few years in which as many as 100 to 200 collections were not made. Each collection of crown rust was cultured in the greenhouse from single pustules, utilizing either Markton or Lee as the host for the cultures. In most instances duplicate cultures were made from each collection. As soon as sufficient inoculum accumulated, it was in turn inoculated on the 13 differential varieties used as standards for determining races of crown rust. Once the races were determined, a composite inoculum was made of all the races found in any one year and all breeding material was either inoculated with this composite inoculum or separately inoculated with each race.

One of the single plant selections made in the F_4 generation was grown continuously up to the F_{10} generation in 1946. In that year a relatively severe natural epidemic of crown rust occurred in most commercial varieties as well as on breeding material grown at the Main Experiment Station. The races observed were races 1 and 45, the latter readily identifiable by its presence on Bond derivatives. Included in the breeding material was a 1/50-acre plot of R19-53-4, the breeding number which later gave rise to Arkwin, R19-53-4-3. While most plants in this plot were heavily infected, one plant was found that showed few infections, represented by small pustules sparsely scattered over the foliage. The seeds of this and of two other plants in the same plot were harvested separately and enough seeds obtained from each to permit rod-row testing in the nursery and seeding in the greenhouse. One of these, R19-53-4-3, when artificially inoculated with races 1 and 45 in the greenhouse, gave an almost immune reaction to race 1, with a few flecks and no pustules, and an intermediate reaction to race 45, with smaller pustules and much fewer spores produced in each pustule than sister selections inoculated at the same time with the same inoculum (see Figure 1).

Fig. 1. The six leaves on the left represent Arkwin, partly resistant to race 45 of crown rust; the six leaves on the right represent a sister selection of Arkwin which is susceptible. Both were inoculated at the same time with the same inoculum.

Genetics for Resistance to Crown Rust

So far as the genetics for resistance to race 1 is concerned, it may be of interest to note that F_2 and certain F_3 populations of this cross nearly always approached 1:1 ratios, indicating that more than one genetic factor pairs were involved in inheritance for resistance in this cross. This is in line with what has been reported by Weetman (8), who found that the Bond type of resistance to race 1 is conditioned by two dominant complementary genes, and is also in line what has been found in Bond crosses by Hayes, Moore, and Stakman (2), by Torrie (7), by Litzenberger (4), and by others which are summarized by Finkner (1).

It appears, however, that the genetics for resistance and susceptibility to crown rust in this cross is much more complex than indicated in the studies on Bond-type resistance published up to the present. As will be noted more fully later, the final selection which gave rise to Arkwin also shows marked escaping qualities

to race 45, with fewer infections, as well as producing smaller pustules under average field conditions. Under greenhouse conditions, escaping qualities are either unobservable or are apt to be attributed to lack of uniform inoculum or to disparity in environmental conditions. Since most genetic studies have been based largely on greenhouse inoculations and seedling reactions, escaping qualities which may occur under natural conditions have largely been overlooked.

As Rosen (5) has reported, there are a number of oats which show marked escaping qualities under natural conditions, notably the Red Rustproofs in their escaping qualities to race 1, although in the greenhouse when artificial inoculations are made these qualities are usually unobservable.

WINTER HARDINESS

1946-47

The winter of 1946-47 was rather severe with seven consecutive days of below freezing temperatures between December 30 and January 5, and another period of four consecutive days of below freezing temperatures between February 7 and 10. The lowest temperature reached in these two periods was -1° F. On the night of January 2-3 less than ½ inch of snow and ice fell and this disappeared rather rapidly so that by the time the lowest temperature appeared, on the night of January 4, there was no cover left. In this period, minimum temperatures of around zero appeared on three consecutive days, January 3 to January 5, inclusive.

Although many varieties and selections were seriously injured or killed by these freezes in the nursery, R19-53-4-3 (Arkwin) suffered slight injury and gave one of the highest grain yields of any variety or selection in the nursery. The percentages of survival and of leaf area killed, obtained on March 20 and 21, 1947, are shown in Table 1.

1947-48

The winter of 1947-48 provided no good test for winter hardiness despite the fact that the temperature dropped to -11° F. on the night of March 11. This exceptionally low temperature had been preceded by a snowfall of 7.8 inches on the previous day and this cover afforded sufficient protection, even to varieties with slight hardiness, so that survival percentages were uniformly high.

Table 1. Percentages of Survival and of Leaf Area Killed on Varieties in the Oat Nursery Following December-January and February Freezes, 1946-47

Variety	Per cent survival	Per cent of leaf area killed
Arkwin	90	40
Traveler	87	46
Letoria	82	61
Stanton	76	64
Nortex 107	74	61
Taggart	65	62
Ferguson 922	62	70
DeSoto	60	76
Fulgrain	49	74
Marmac	38	86
Fulghum 708	28	91
Delair	27	83
Victorgrain	27	85

1950-51

The winter of 1950-51 provided an excellent test for winter hardiness. An extremely severe epidemic of crown rust appeared in the nursery, where a large part of the planting was made on September 11 and where growth was much greater than in the large varietal test plots planted later. It is well known that rusted plants lose winter hardiness, and in the presence of this epidemic even the hardiest varieties such as Forkedeer and Fulwin were almost completely destroyed by the subsequent freezes.

The first freeze appeared on November 11, with a minimum temperature of $+11^\circ$F. and with no snowfall. This had been preceded by a prolonged period of mild or rather warm fall weather during which the epidemic of crown rust developed on all susceptible varieties and selections that were sown early in September. Crown rust readings were made on October 11 and 27. Readings on percentage of survival were made November 22, following the first freeze. Table 2 presents these readings.

Table 2. Percentages of Crown Rust on Varieties in Oat Nursery and of Survival Following the Freeze of November 11, 1950

Variety	Per cent crown rust [1]	Per cent survival [2]
Arkwin	60	90
DeSoto	10	90
Letoria	25	90
Traveler	30	90
Fulgrain	35	85
Stanton	30	85
Ferguson 922	45	50
Nortex 107	35	45
Forkedeer	83	30
Fulghum 708	80	30
Taggart	80	30
Lee	90	3

[1] Modified Cobb's scale; readings made October 11 and 27.

[2] Reading made November 22.

Arkwin, with its intermediate reaction and escaping qualities to race 45, the one that was very largely concerned in this fall epidemic of 1950, showed one of the highest percentages of survival in the nursery. Although it had considerably more rust than such varieties as Traveler, DeSoto, Letoria, Fulgrain, and Stanton, varieties that are definitely resistant to race 45, nevertheless it survived fully as well as the best of these.

The data in Table 2 show quite clearly what happens to varieties fully susceptible to crown rust race 45, as are Forkedeer, Taggart (see Figure 2), and Fulghum 708. These three varieties are all Fulghum derivatives; thus all are related to Arkwin. Taggart in particular is related, since it possesses germ plasm of both Fulghum and Bond. Considering the exceptional winter hardiness of Forkedeer when it is free from rust, the logical explanation for the much greater percentage of survival of Arkwin compared with Forkedeer rests largely in Arkwin's partial resistance and escaping qualities to race 45 and not necessarily on any inherently greater hardiness. It should be noted that severe rust epidemics in the fall have not been very common in Arkansas, although they may become more so in the future as greater acre-

Fig. 2. Part of the oat plots, photographed November 28, 1950, following a very severe epidemic of crown rust race 45 and an early November freeze. The plot on the left is Taggart, with 30 per cent survival; the plot on the right is Arkwin, with 90 per cent survival.

age is seeded early in order to produce good fall and winter pasture.

In addition to the early November freeze, the winter of 1950-51 afforded additional tests for winter hardiness. Some of the plots, especially the large 1/50-acre varietal test plots, were seeded relatively late, on September 26, and very largely escaped the severe epidemic of crown rust that developed on the early seeded plots of the same varieties. Thus it became possible to test for winter hardiness uncomplicated by a rust epidemic. The additional periods during the winter of 1950-51 which offered good tests for winter hardiness are presented in Table 3, with their minimum and maximum temperatures and amount of snowfall. These records were obtained relatively close to the test plots and constitute the official U. S. Weather Bureau records for the Agricultural Experiment Station, Fayetteville.

It may be noted in Table 3 that there were four days during the winter of 1950-51 when the temperature went down to 0°F. or below. The lowest, −8°F., came when there was 1 inch of snow on the ground, not enough to offer much protection to most of the foliage but seemingly enough to offer some protection to the embryonic crown region at about the level of the soil. As a whole there was comparatively little complete killing of plants on plots

Table 3. Records of Minimum and Maximum Temperatures and Snowfall at Main Experiment Station During Coldest Periods of the Winter of 1950-51

Date	Minimum temperature	Maximum temperature	Inches of snowfall and maximum depth on ground
	Degrees F.	*Degrees F.*	*Inches*
November			No snowfall in month
24	9	29	
25	14	49	
26	20	45	
27	28	57	
28	24	54	
December			Total for month: 3.9 Maximum depth on ground, 1 inch on December 5 1.8 inches fell Dec. 5 1.1 inches fell Dec. 6
3	18	54	
4	22	46	
5	17	41	
6	0	17	
7	−4	20	
8	7	38	
9	19	50	
10	26	45	
January			Total for month: 2.3 Maximum depth on ground, 2 inches on Jan. 31
29	3	12	
30	5	14	
31	7	13	
February			Total for month: 3.0 Maximum depths on ground, 3 inches on Feb. 15; 2 inches on Feb. 1; 1 inch on Feb. 2.
1	−5	8	
2	−8	28	
3	18	37	

seeded September 26 or later. Even with varieties that do not have much winter hardiness, such as Fulgrain, Victorgrain, Ferguson 922, Nortex 107, Fulghum 708, Stanton, DeSoto, and Taggart, the percentage of survival did not fall below 85 per cent. However, even though few plants were completely killed, there was so much injury to varieties that are not very hardy that their yields in grain were seriously reduced (see Table 8, page 18.)

The winter of 1951-52 was comparatively mild so that no good test for hardiness was obtainable.

Summarizing the data on winter hardiness, it appears that Arkwin possesses considerable winter hardiness, approximately as much as Forkedeer or Fulwin, two of the hardiest varieties now known.

FORAGE VALUE

There has been a large increase in animal production in Arkansas in recent years, as well as an increase in the relative importance of livestock as a source of income. Considering the fact that the state rarely produced sufficient feed for its animals even before the large increase, it is obvious that there is great need for much additional production of feed crops. The shortage of feed is usually most pressing during the fall and winter seasons.

Winter oats of adapted varieties offer one of the most economical sources of nutritious feed during the fall and winter months, although comparatively few Arkansas farm people have taken advantage of this up to the present. Most of the oat acreage sown is utilized for hay or grain crops.

The potential value of oats for fall and winter pasture became clearer during the course of these investigations. By clipping and weighing measured portions of each variety or selection during the fall and winter months, measures of the amount of pasturage available were obtained. Likewise, protein analyses were made to determine if there were any marked differences in quality between varieties or selections. Protein content is one important measure of quality.

Protein Content of Winter Pasture

After more than 2,700 protein determinations had been made in the study, it appeared that there were greater differences in protein content within any one variety or selection than there were between varieties or selections. These differences could largely

be accounted for by differences in soil fertility and in weather conditions. The range in crude protein content is exemplified in Tables 4 and 5.

It should be noted that the 1944-45 clippings came from a field that had been in alfalfa meadow for two years previously, the alfalfa having been replaced largely by weeds the second year. No nitrogen was applied at seeding time, the only fertilizer used being 200 pounds of 20 per cent superphosphate per acre. The 1945-46 clippings were obtained from three different fields, all of which had been in meadow crops. One of the fields received no fertilizer at seeding time, while the other two fields received a complete fertilizer at seeding, as noted below.

Probably the best illustration of the influence of soil fertility on protein content was obtained in the November 1945 clippings of oats. The first four replicates came from a section of

Table 4. Variation in Percentage of Crude Protein of Oat Forage, 1944-45

Variety or selection	Month clipped	Crude protein[1]		Number of replicates
		Range in percentage	Average percentage	
R19-53-4[2]	November, 1944	16.8–33.4	23.0	4
Lee	" "	19.9–37.3	29.1	8
Ferguson 922	" "	19.8–23.7	21.7	5
Stanton	" "	21.6–33.1	27.4	8
Letoria	" "	18.5–31.2	25.1	8
DeSoto	" "	18.4–31.3	25.6	6
Traveler	" "	24.4–35.4	27.5	7
R19-53-4	December, 1944	16.6–21.0	18.8	2
Lee	" "	19.2–22.6	21.4	2
Ferguson 922	" "	16.0–17.1	16.6	2
Stanton	" "	17.2–23.4	20.1	4
Letoria	" "	15.6–22.3	18.7	3
DeSoto	" "	17.7–19.2	18.5	2
Traveler	" "	19.5–21.6	20.6	2
R19-53-4	January, 1945	13.7–21.4	17.1	4
Lee	" "	18.9–21.7	21.4	4
Ferguson 922	" "	13.9–18.8	16.8	4
Stanton	" "	12.9–19.0	16.9	4
Letoria	" "	12.9–23.6	18.4	4
DeSoto	" "	17.2–22.6	19.3	4
Traveler	" "	15.0–23.3	19.7	4
R19-53-4	February, 1945	12.9–15.1	13.9	4
Lee	" "	12.5–15.6	14.6	4
Ferguson 922	" "	13.0–14.9	14.1	4
Stanton	" "	13.9–15.9	15.0	4
Letoria	" "	10.8–13.8	11.9	4
DeSoto	" "	9.8–17.3	13.1	4
Traveler	" "	14.1–16.4	15.1	4
R19-53-4	March, 1945	12.5–20.3	15.6[3]	4
Lee	" "	13.9–16.1	15.5[3]	4
Ferguson 922	" "	12.3–16.8	14.4[3]	4
Stanton	" "	12.6–14.6	13.6[3]	4
Letoria	" "	10.8–16.5	13.5[3]	4
DeSoto	" "	11.3–15.4	12.9[3]	4
Traveler	" "	12.8–16.5	15.3[3]	4

[1] Dry weight basis.

[2] Breeding number from which Arkwin was selected.

[3] Difference required for significance at 5 per cent level—2.4 per cent.

Table 5. Variation in Percentage of Crude Protein of Oat and Other Small Grain Forage, 1945-46

Variety or selection	Month clipped	Crude protein[1] Range in percentage	Crude protein[1] Average percentage	Number of replicates
R19-53-4[2]	November, 1945	22.9–31.6	27.8	12
Lee	"	23.3–33.3	29.4	10
Ferguson 922	" "	23.3–33.6	28.7	10
Stanton	" "	20.3–33.6	28.7	12
Letoria	" "	24.0–33.8	28.9	12
DeSoto	" "	24.8–35.6	29.9	10
Traveler	" "	22.9–37.0	28.8	12
Sanford wheat	" "	21.2–24.3	22.9	4
Fayette barley	" "	23.3–24.3	23.7	4
Texan barley	" "	21.9–25.6	23.2	4
Balbo rye	" "	20.6–23.3	22.5	4
Abruzzi rye	" "	22.0–25.5	24.0	4
R19-53-4	December, 1945	14.2–20.5	16.0	5
Lee	" "	15.4–21.4	19.2	4
Ferguson 922	" "	15.6–20.6	18.7	3
Stanton	" "	15.4–21.8	18.2	6
Letoria	" "	15.4–21.9	18.0	5
DeSoto	" "	17.0–23.8	20.1	6
Traveler	"	12.6–19.[illegible]	17.0	5
Sanford wheat	"	17.6–18.8	18.2	4
Fayette barley	"	19.9–20.6	20.3	4
Texan barley	"	17.4–21.4	18.9	4
Balbo rye	"	15.1–19.1	16.9	4
Abruzzi rye	"	16.9–22.9	19.1	4
R19-53-4	January, 1946	14.7–18.9	16.7	5
Lee		14.3–22.9	18.6	4
Ferguson 922		11.8–20.4	16.3	3
Stanton		12.2–21.9	17.8	6
Letoria	" "	16.3–20.7	17.7	5
DeSoto	"	17.8–21.4	19.5	6
Traveler	"	12.6–17.3	15.2	5
Sanford wheat	"	10.8–15.6	13.9	4
Fayette barley		8.5–19.4	14.7	4
Texan barley	"	14.9–16.9	15.9	3
Balbo rye	" "	10.6–14.6	12.8	4
Abruzzi rye	"	13.9–15.6	14.8	4
R19-53-4	February, 1946	10.0–16.7	13.1	5
Lee		14.1–21.1	17.5	4
Ferguson 922	" "	9.9–20.8	14.7	3
Stanton	"	9.3–21.5	15.4	6
Letoria		11.9–21.6	16.0	5
DeSoto		12.1–21.6	16.8	6
Traveler		10.1–21.2	14.5	5
Sanford wheat	"	11.3–16.3	14.6	4
Fayette barley		11.2–16.1	14.4	4
Texan barley		10.4–14.4	12.4	4
Balbo rye		11.4–15.0	12.8	4
Abruzzi rye		12.6–16.9	14.[illegible]	4
R19-53-4	March, 1946	11.6–13.8	1[illegible].3	4
Lee		13.5–16.7	15.1	2
Ferguson 922		11.7–14.9	1[illegible].3	2
Stanton		12.9–14.6	13.9	4
Letoria	"	12.6–14.7	13.7	4
DeSoto		12.3–15.4	14.2	4
Traveler		12.4–15.7	13.9	4
Sanford wheat		10.8–18.7	15.[illegible]	4
Fayette barley		14.2–18.1	16.4	4
Texan barley	"	16.6–19.4	18.3	4
Balbo rye		15.4–19.4	1[illegible]	4
Abruzzi rye	"	16.8–21.3	18.8	4

[1] Dry weight basis.

[2] Breeding number from which Arkwin was selected.

the University farm where no fertilizer had been applied at seeding, while the last eight replicates of each variety were obtained from sections that received, at seeding, a complete fertilizer consisting of 75 pounds ammonium sulphate, 300 pounds of 20 per cent super-

phosphate, and 50 pounds of muriate of potash per acre. The average percentage of crude protein for the replicates of the seven oat varieties derived from the unfertilized soil was 24.8 per cent; the average for the replicates on fertilized soil was 30.6 per cent.

Considering the fact that the replicates on fertilized soil received only 9 pounds of nitrogen per acre at seeding and no additional nitrogen until after the last clippings had been made in early March, it may be concluded that 30.6 per cent protein probably represents a minimum that can be expected from well managed upland soil of medium fertility that has been in lespedeza or other legume meadow. If the recommended amounts of from 400 to 600 pounds of 5-10-5 or 5-10-10 per acre are applied to such soils, it may be assumed that the protein content of small grain pasture during November will average better than 30.6 per cent, from 30 to 35 per cent probably being a conservative estimate. However, if the data in Tables 4 and 5 are used as a further guide, one may expect the percentage of protein to be reduced gradually during the winter.

For comparative purposes and as a further guide to what may be expected from small grain pasturage during the fall and winter, the protein percentages of one wheat variety and two varieties of barley and of rye are also presented in Table 5. It will be noted that these percentages are quite comparable to those obtained from oats under the same field conditions.

As a whole the data shown in Tables 4 and 5, as well as much additional information obtained largely from numerous breeding selections of oats and wheat, seemingly indicate a pasturage rich in protein. This would probably apply to most varieties of winter oats including Arkwin, although the latter is represented in the tables only by the selection R19-53-4, from which Arkwin was reselected.

Pasturage Obtained from Arkwin

The amounts of pasturage obtained from Arkwin during the winters of 1949-51, compared with those from the standard varieties, are shown in Table 6. These amounts were obtained by clipping 12 square feet from each variety once a month from November to early March. While the foliage was held up with one hand, a sickle was used to clip with the other hand, the clip being made 1 to $1\frac{1}{2}$ inches above the soil line. Although this method is quite

Table 6. Average Amounts of Green Matter and Oven-Dry Matter Obtained from Oat Pastures During the Winters 1949-51, Main Agricultural Experiment Station

Variety	1949-50		1950-51 [1]		1951-52	
	Green matter	Oven-dry matter	Green matter	Oven-dry matter	Green matter	Oven-dry matter
	Pounds per acre					
Arkwin	9,620	2,066	3,054	956	7,120	1,482
Lee	8,266	2,048	912	390 [2]	6,504	1,325
Ferguson 922	8,473	1,946	1,209	426	——	——
Stanton	6,984	1,824	1,351	523		
Letoria	7,055	1,618	2,785	865	——	——
DeSoto	5,649	1,537	2,002	677	——	——
Traveler	7,697	1,847	2,022	693	——	——
Fulghum 708	7,770	1,959	1,811	588	——	——
Victorgrain	8,610	2,064	1,714	608	——	——
Forkedeer	——	——	1,983	716	——	——
Fulgrain	——	——	2,283	923	——	——

[1] The severe winter of 1950-51 caused much killing of oat foliage. Prior to the early November freeze, the amount of green matter available in pounds per acre was as follows: Arkwin 5,557, Lee 4,925, Ferguson 922—3,102, Stanton 2,641, Letoria 4,010, DeSoto 3,945, Traveler 3,099, Fulghum 708—5,289, Victorgrain 4,423, Forkedeer 4,415, Fulgrain 3,834; the amount of oven-dry matter in pounds per acre was: Arkwin 1,037, Lee 867, Ferguson 922—632, Stanton 583, Letoria 867, DeSoto 818, Traveler 761, Fulghum 708—980, Victorgrain 923, Forkedeer 851, and Fulgrain 859.

[2] The comparatively high proportion of dry matter was due to the abnormal amount of dead foliage occasioned by the winter freezes of 1950-51.

laborious, it seems to be much more accurate than mowing with a machine, so far as obtaining the amounts of growth available for cow pasturage is concerned. Even power mowers with protruding teeth do not hold the foliage rigidly enough to permit the blades to cut the available growth. The successive clippings were made from different locations within each plot so that the figures shown are not additive amounts but are averages of five clippings. While there often is additional growth of plants clipped in November and December, this is usually so slight during the winter at the Main Agricultural Experiment Station that it is ignored in Table 6. The figures therefore represent somewhat less pasturage than was actually available. Because of the space needed for a relatively large number of wheat breeding numbers in 1951-52, only two oat varieties were used in the clipping plots in that year. It may be observed in Table 6 that in each year in the three-year period, Arkwin led in the amount of green matter and in dry weight. However these data do not fully reveal the qualities of Arkwin as a fall and winter pasture oat. These qualities consist of rapidity of early growth, relatively large foliage, and an upright growth habit, coupled with considerable winter hardiness.

As to rapidity of early growth (see Figure 3), this appears to be due largely to its vigor, which to some degree at least is an

expression for disease resistance to seedling diseases including Helminthosporium blight, viruses, nematodes, and drought injury. Its resistance to drought was particularly noticeable during the exceedingly dry fall of 1952 when there was less than an inch of rainfall between the time of seeding on September 16 and the middle of November. Arkwin made approximately twice as much growth as 15 other varieties at the Main Station, including such commonly grown varieties as Traveler, Victorgrain, Fulgrain, Ferguson 922, DeSoto, and Stanton.

The upright growth habit and high degree of winter hardiness possessed by Arkwin (see Figure 4) make it especially adapted to fall and winter grazing. While there are a number of varieties available that have an upright or intermediate habit of growth, such as Taggart, Delair, Victorgrain, Fulgrain, and Fulghum 708, none of these possess much winter hardiness. A variety that lacks winter hardiness becomes much more subject to winter injury when it is grazed.

Parenthetically it may be noted that when any variety is grazed closely, it loses a considerable part of its hardiness, and that even hardy varieties such as Arkwin, Forkedeer, and Fulwin can be winter-killed if grazed too closely. On the other hand,

Fig. 3. Oat plots at the Main Experiment Station photographed November 14, 1952, following an extreme fall drought. At the left is DeSoto, the center plot is Arkwin, and at the right is Traveler.

Fig. 4. The upright growth of Arkwin can be seen in this picture photographed November 12, 1951. The three rows starting at the lower right corner are Arkwin, the three rows in the center are Traveler, and the three at the left are Mustang.

Arkwin and other rapidly growing, upright types may be highly benefited by moderate fall and winter grazing, since this removes excessive growth that might otherwise be killed by winter freezes or that might permit greater increase of harmful insects such as aphids. While Arkwin is the only variety known to the writers that combines an upright growth habit with much winter hardiness, its uprightness and large foliage render it particularly subject to leaf killing or "tipping" by winter freezes, in contrast to prostrate varieties which escape such injury by having their foliage close to the soil.

GRAIN YIELDS

During the years 1947-50, when Arkwin was grown in the nursery, it made an outstanding record in grain yield. In 1947 it yielded at the rate of 126.0 bushels per acre, outyielding all commercial varieties in the test. As this yield was derived from a single rod row, it is not of statistical value, although it did indicate a high yielding capacity following a severe winter (see Table 1). During 1948 Arkwin also gave promise of producing a high yield but this was largely vitiated by a severe hail storm that destroyed a considerable part of the nursery. In 1950 it was grown in the nursery as well as in the larger varietal test blocks. The nursery

Table 7. Grain Yields in Oat Nursery, 1949 and 1950

Variety	1949	1950	Average, 1949-50
	Bushels	*per*	*acre*
Arkwin	79.7	84.4	82.1
Forkedeer	71.9	74.8	73.4
Letoria	74.9	62.0	68.5
Taggart	70.7	62.9	66.8
Traveler	69.3	60.7	65.0
Nortex 107	75.0	54.6	64.8
Fulghum 708	68.5	60.0	64.3
Victorgrain	57.9	67.9	62.9
Stanton	58.2	64.7	61.5
Fulgrain	74.2	47.7	61.0
DeSoto	76.0	44.8	60.4
Ferguson 922	59.0	45.0	52.0
L. S. D. 5% level [1]	3.2	4.1	

[1] Yields must differ by this amount for the difference to be statistically significant.

yield data for 1949 and 1950 are shown in Table 7. These data are taken from 3 rod rows replicated 9 times. Arkwin led all commercial varieties in the tests for these two successive years and probably did so during the whole four-year period of nursery testing.

Arkwin has now been tested for three years in the larger varietal test plots at the Main Station. The results are shown in Table 8. These larger plots were replicated six times. It may be noted that Arkwin led in yield each year during the three years, or as long as it has been in these tests. No other variety has led in grain yields for three successive years at the Main Experiment Station although the recorded tests started in 1887 and have continued regularly up to the present.

Table 8. Grain Yields in One-Fiftieth-Acre Varietal Test Plots, Main Experiment Station, 1950-52

Variety	1950	1951	1952	Average, 1950-52
	Bushels		*per*	*acre*
Arkwin	67.7	63.3	88.6	73.2
Traveler	65.6	51.8	80.7	66.0
Fulwin	55.8	58.7	78.6	64.4
Stanton	66.4	42.1	74.0	60.8
Traveler 15-8	66.2	45.6	70.3	60.7
Fulghum 708	53.0	45.2	72.9	57.0
Lee	66.2	37.0	67.5	56.9
Letoria	63.6	41.4	63.3	56.1
Victorgrain	54.4	40.7 [1]	63.0	52.7
DeSoto	58.9	37.2	57.7	51.3
Fulgrain	50.6	47.7	53.4	50.6
Taggart	59.9	45.3	42.4	49.2
Ferguson 922	48.7	24.2	49.5 [1]	40.8
Nortex 107	45.6	28.1	36.3	36.7
L. S. D. 5% level [2]	5.3	3.7	8.4	

[1] Seed badly mixed prior to seeding; yield data shown are calculated.

[2] Yields must differ by this amount for the difference to be statistically significant.

At the Rice Branch Experiment Station, in Stuttgart, Arkwin has been grown for two years in the varietal test. The records for the two years are shown in Table 9. These plots were slightly less than 1/50-acre and were replicated four times.

The data in Table 9 consist only of two years' testing and therefore are not as reliable as those from the Main Station. However, the average yield of Arkwin of 93.2 bushels per acre is sufficiently good to indicate adaptability to that area. The 1951 yield of 84.1 bushels followed an exceptionally cold winter with a minimum temperature of 2 F., while the 1952 yield of 102.3 bushels followed a relatively warm winter. Arkwin outyielded Ferguson 922, one of the most commonly grown varieties in the rice-growing area of the state, by about 67 bushels in 1951 and by about 10 bushels in 1952. But, from the data in Table 9, it may be concluded that Arkwin should not replace Fulgrain, Victorgrain, or Traveler in the rice-growing area.

When the performances of Arkwin in grain yield tests of the Main Agricultural Experiment Station and the Rice Branch Experiment Station are added to yields obtained by individual farmers in diverse parts of the State, it seems that satisfactory yields can be expected in most of the state from the southern to

Table 9. Grain Yields in One-Fiftieth-Acre Test Plots at the Rice Branch Experiment Station, 1951-52[1]

Variety	1951	1952	Average, 1951-52
Fulgrain	80.3	123.2	101.8
Victorgrain	83.1	116.6	99.9
Traveler	85.0	111.2	98.1
Arlington	90.0	105.8	97.9
Mustang	91.5	100.2	95.9
Stanton	84.1	106.3	95.2
Traveler 15-1	85.0	104.2	94.6
Taggart	79.0	110.0	94.5
Letoria	84.5	103.7	94.1
Traveler 15-8	85.6	101.8	93.7
Arkwin	84.1	102.3	93.2
Maximcrop	76.7	108.8	92.8
DeSoto	79.9	104.9	92.4
Atlantic	86.0	89.9	88.0
Fulghum 708	63.3	98.4	80.9
Delair	48.3	112.1	80.2
Lee	69.9	84.4	77.2
Nortex 107	45.8	80.0	62.9
Delta Red	16.3	94.8	55.6
Ferguson 922	17.2	92.4	54.8
L. S. D. 5% level[2]	10.1	12.0	

[1] Data obtained in cooperation with C. Roy Adair, agronomist, Division of Cereal Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Dept. of Agriculture.

[2] Yields must differ by this amount for the difference to be statistically significant.

the northern boundary, including the hilly areas and the low-lying parts. While tests by farmers cannot be expected to have the accuracy required in experimental work, it may be of interest to note that following the very cold winter of 1950-51 which reduced the state's average yield to one of the lowest in the last decade, the five farmers who tested Arkwin prior to its release all obtained good yields.

Despite the good grain yields that have been obtained from Arkwin, it would be a mistake to assume that this variety should replace to any large degree any of the recommended varieties now in use. This will be more fully discussed later.

DISEASE RESISTANCE

It has been indicated previously that Arkwin possesses a high degree of resistance to races 1, 7, and 16 of *crown rust*, and an intermediate or partial resistance and escaping qualities to race 45 of this rust. This race and closely related ones are at present (1952) the most abundant in Arkansas, as well as in the country as a whole. It has also been indicated in Table 2 that in the presence of a very severe fall epidemic of race 45, Arkwin had sufficient escaping qualities to this race so that it showed 90 per cent survival, when fully susceptible varieties such as Forkedeer, Taggart, and Fulghum 708 suffered serious reduction in stand. No data are available on the effects of severe natural spring epidemics of race 45 on grain yields of Arkwin although some are available for artificial epidemics.

Each year artificial epidemics were created in the nursery by injecting heavy spore suspensions into plants and by transplanting oat plants that had been infected in the greenhouse by means of artificial inoculations. However, since 1947, weather conditions have been unfavorable for rapid spread of inoculum at the Main Agricultural Experiment Station, except in 1949. In that year, when Lee showed 90 per cent of its leaf area infected, Arkwin showed 50 per cent on June 2 and yielded at the rate of 79.7 bushels per acre, the highest yield obtained in the nursery. Nevertheless, the mature plant reaction of Arkwin to race 45 in 1949 approached a fully susceptible type, as it did in 1952. But in the latter year, as in previous ones, the amount of infection was considerably lower than on the check variety Lee, which gave a reading of 50 per cent when Arkwin had 15 per cent.

During the years 1951 and 1952, Arkwin was tested at all the Branch Experiment Stations in the state. A sufficient amount of crown rust was present on susceptible varieties only at two stations to afford a good test. At the Fruit and Truck Branch Station, Hope, in 1951, Taggart showed 30 per cent crown rust and Arkwin showed a trace. In 1952, when Taggart showed 20 per cent and Fulwin 50 per cent at that Station, Arkwin gave a reading of trace plus. At the Cotton Branch Experiment Station, Marianna, in 1951, Fulwin showed 80 per cent, Taggart 3 per cent, and Arkwin trace plus. Identification of collections made at these Stations indicated that race 45 was mainly involved.

A summary of all the data obtained on Arkwin in its reaction to crown rust race 45 indicates the following: the usual reaction, particularly on seedlings, is intermediate, 2-3 type, which in mature plants is often replaced by a susceptible 3-4 type. However, the amount or severity of infection is usually considerably lower than on fully susceptible varieties.

As to the reaction of Arkwin to the new race 101, it appears to be fully susceptible, so that if this race becomes as common as race 45 is in 1952, Arkwin will without much doubt suffer seriously.

Concerning the reaction of Arkwin to *stem rust*, a disease which is rarely important on winter oats in Arkansas, it appears to be susceptible to races 6 or 8 but partly resistant to race 7.

With reference to its reaction to *loose* and *covered smuts*, Arkwin seems to be resistant to all races currently prevalent in Arkansas. During the past three years, dehulled seeds have been inoculated each year with a mixture of smut collections obtained in diverse parts of the state and the percentage of smut infection averaged 5 per cent for Arkwin as compared with 70 per cent for Lee.

Fragmentary evidence suggests that Arkwin possesses some resistance or escaping qualities to *anthracnose*, a disease that has not been very abundant during the past two years although it was greatly so for a number of years previously. In 1951, when 10 per cent of the leaf area of Stanton, Letoria, DeSoto, Taggart, and Nortex 107 was found infected by anthracnose at the time when most of the varieties were in the milk stage, Arkwin showed a trace of anthracnose at the Fruit and Truck Branch Experiment Station, Hope. Obviously this evidence is insufficient to indicate definite resistance, although it may be suggestive of such.

The reaction of Arkwin to *Helminthosporium leaf spot* (leaf blotch) caused by *Pyrenophora (Helminthosporium) avenae* is uncertain. The mature plant reaction is such that number and size of spots differ slightly or not at all from most commercial varieties, although at the Fruit and Truck Station in 1951 it had only a trace of leaf spot when Ferguson 922, Stanton, Letoria, Delta Red, and Carolina Red showed 5 to 10 per cent of the leaf area infected when the plants were mostly in the milk stage. However, in the earlier stages of growth, Arkwin frequently has shown fewer infections at the Main Agricultural Experiment Station than the check variety, Lee. This seemingly was true in 1947, 1949, 1950, and 1952, years when leaf spot was particularly abundant at this station. But it is not clear whether this is due to a true resistance to this disease or merely to chance occasioned by the fact that Arkwin is resistant to certain virus diseases, as will be noted later. These diseases cause the death of young plants, converting them into exceptionally favorable media for the sporulation of *Helminthosporium avenae*, thus creating large, localized amounts of inoculum (6). Since such inoculum has not been observed in plots of Arkwin when it has been grown with a number of other varieties, it may well be that Arkwin's relative freedom from leaf spot in early stages of growth is due to the absence of large amounts of inoculum rather than to any true resistance.

Arkwin is highly resistant or immune to *Helminthosporium blight* caused by *Helminthosporium sativum* var. *victoriae (Helminthosporium victoriae* Meehan and Murphy). Seeds and seedlings of Arkwin have been repeatedly inoculated with different single-spore isolates of this fungus with no signs of infection, while check inoculations on susceptible varieties such as Stanton or DeSoto resulted in large numbers of infections. Inoculations, all made in the greenhouse, were first made on Arkwin in 1948 and repeated in 1950, '51, and '52.

Arkwin appears to be resistant to *red spot mosaic* and to another virus tentatively identified as *yellow dwarf* (6) but which may also be considered as barley false stripe. These two virus diseases caused considerable damage to susceptible varieties at the Main Agricultural Experiment Station in 1952. Since the viruses of these diseases appear to be transmitted by aphids, and since aphids are likely to be more abundant on relatively large, thick

growth, such as is necessary for good fall and winter pasture, there is a likelihood that the virus diseases spread by aphids may become more abundant as more oat acreage is used for winter pasture. Any additional oat acreage or increased acreage of any other small grain is likely to increase the aphid population and with such increase, there may well be a simultaneous increase in virus diseases. In any case, Arkwin appears to show a high degree of resistance to the two viruses mentioned (see Figure 5). Soil-borne viruses of oats have not been observed in Arkansas but judging by tests conducted by investigators in southeastern states, Arkwin seems to possess some resistance to these viruses.

As to bacterial diseases, including *halo blight* and *stripe blight*, in only one year have they been present in sufficient amounts to permit varietal comparisons. In that year (spring of 1953) Arkwin showed a trace of these diseases when standard varieties ranged from a trace plus (Fulwin) to 20% (Victorgrain 48-93).

Concerning the non-parasitic disease known as *sterility* or *blast*, there is in general no difference to be observed between the amount usually found on Arkwin and that on standard commercial varieties. In 1952 there was considerably less sterility on Arkwin

Fig. 5. The plot of Letoria oats at the right of the picture shows yellowing and dwarfing (virus) disease; the plot of Arkwin at the left shows none. The photograph was taken May 9, 1952.

than on most commercial varieties in the varietal test plots at the Main Agricultural Experiment Station, but this may have been associated with the greater amount of virus diseases present in these other varieties (6).

It has previously been noted that Arkwin possesses resistance to a number of seedling diseases including resistance to drought injury.

Summarizing the information on resistance to parasitic diseases, it appears that Arkwin possesses considerable resistance to most of the important parasitic diseases now common in Arkansas. If to this is added resistance to drought injury in the seedling stage and resistance to low temperature injury, it seems that this variety is exceptionally well adapted to Arkansas conditions. Despite such resistance, if Arkwin should replace to any large extent the other varieties now in common use in this state, it would without much doubt suffer the same fate that has befallen all other new varieties that replaced old standard varieties to such an extent that many of the old ones became extinct. Whenever this occurred, as when Victoria-Richland selections replaced numerous old standard varieties throughout the spring-oat area of the country, and when D69-Bond selections replaced the Victoria-Richland selections, it took very few years for some old or new disease, such as Helminthosporium blight[2] and race 45 of crown rust, to reduce in large measure the usefulness of the new varieties.

GENERAL RECOMMENDATIONS FOR THE USE OF ARKWIN IN DIVERSE PARTS OF THE STATE

From the standpoint of disease control, Arkwin should only be recommended to those growers who have not obtained satisfactory yields from other varieties that were given fair trial, and to those who are in particular need of fall and winter pasture. Growers who do not prepare good seedbeds, who do not fertilize adequately, or who do not plant at recommended dates and rates, are not likely to have much more success with Arkwin than with any other variety recommended for their area. To prevent widespread epidemics of rust, smut, blight, and other diseases, the

[2] Probably an old disease that never reached large epidemic proportions so long as diverse varieties with different germ plasm were commonly used in an area. Over 50 years ago Harvey (3) noted a disease on oats in Maine which he associated with a species of Helminthosporium. The symptoms he described very briefly, the spore measurements, and his description of the spores could easily be applied to the disease and the fungus that we now associate with Helminthosporium blight.

safest practice is to grow as many different recommended varieties as possible in any one county and to disperse these varieties so that no one is grown in large adjoining acreages.

For the *colder parts of the state*, particularly in the hilly areas, there is need for additional varieties that have as much or more cold resistance than Traveler and Stanton. Arkwin should have a definite place in these parts although not to the exclusion of Traveler and Stanton. This area would include most of the northern half of the state exclusive of the delta region, but including the Ouachita hilly area.

For the *delta region* and in the *southern half of the rice-growing area* the need for Arkwin is not so evident. There is comparatively little demand for winter pasture in these parts of the state, oats being grown mainly for grain as a cash crop, and such standard varieties as Ferguson 922, Nortex 107, Traveler, Victorgrain, DeSoto, and Fulgrain usually produce satisfactory grain yields. The two-year tests of Arkwin at the Rice Branch Experiment Station do not indicate that Arkwin will produce better grain yields in an average year in these parts of the state than most of varieties mentioned. However, following exceptionally cold winters, as the one of 1950-51, there is little doubt that Arkwin will yield better than Ferguson 922 and Nortex 107. In so far as the rice-growing area acts as a seed-producing section for the state as a whole, Arkwin should in part replace Ferguson 922, Nortex 107, and other Red Rustproof strains.

For the *southern half of the state exclusive of the delta and the rice-growing region*, Arkwin can be recommended along with Traveler, Victorgrain, DeSoto, and the Red Rustproofs. Arkwin probably will be especially useful wherever fall and winter pasture is desired in this part of the state. But it should not be used in the two southern tiers of counties because of the greater danger of epidemics of crown rust and the presence of race 101 of this rust in these counties. It has been noted previously that Arkwin is fully susceptible to this race. In southern counties most reliance should continue to be placed on the Red Rustproofs including New Nortex, Appler, Ferguson 922, Nortex 107, and Delta Red, despite the fact that these varieties will occasionally rust.

BOTANICAL AND AGRONOMIC CHARACTERS

Seed Characters

Arkwin (C. I. 5850) may be classified as a red oat, *Avena byzantina*, although the color of the lemma frequently approaches that of the common or so-called white oat group, *A. sativa*. It usually has two fertile florets in each spikelet with very few, commonly no basal hairs on the primary floret. Part or all of the rachilla usually remains attached to the secondary floret and disarticulation at the apex of the rachilla is present in only a small percentage of spikelets. It is this shortage of apical rachilla articulation of the secondary floret which determined the placing of Arkwin in the red oat group although it otherwise may be placed just as readily in the white oat group. Only the primary floret is awned and that in only 30 to 50 per cent of the spikelets, most of the awns being relatively thin and weak, a few black and twisted at the base, and usually lost in threshing. As with most Fulghum derivatives, so-called wild or fatuoid types are not rare and these commonly possess numerous basal hairs on the primary floret and heavy awns on both the primary and secondary florets.

The color of the lemma and palea resembles that of the mother parent, Tennessee 1922 (selection from Fulghum C. I. 2499), being usually lighter colored. The color of the lemma may be described as light yellowish tan, the tan occasionally fading and being partly or wholly replaced by yellow tints. This is particularly noticeable when it is grown as a spring oat (as it probably never should be). As with other oat varieties, the color varies somewhat with seasons and with locality. At the Main Agricultural Experiment Station the color of the lemma is usually lighter than at the Rice Branch Station and approaches the warm buff of Ridgway's color standards (Plate XV) or cream buff (Plate XXX). In Maerz and Paul's tables of color it is close to Plate 10, I4, (pond lily).

The base of the primary floret is slightly angular or almost perpendicular to the main axis of the grain and not a sharp angle of abscission as in Taggart or in the Red Rustproof strains. There is no suggestion of a sucker-mouth type of base except in an occasional fatuoid. Likewise, the base appears as a more or less hollow ring with a solid central core, the latter either occupying

a considerable part of the base or simulating a somewhat narrow septum dividing the base into two parts.

The seeds representing the primary florets are plump and large in size. The total length of seeds with unclipped or unbroken lemma tips average 14 to 15 mm.; when uniformly hand clipped to simulate clipping machines, they average 9.5 to 10.5 mm. The width averages from 2.5 to 3.5 mm. at the greatest diameter, a point at or below the center of the long axis of the seed. The thickness, determined by micrometer caliper measurements, averages 2.1 to 2.5 mm.

The seeds representing the secondary florets are also large and plump, their relatively large size being one of the distinctive characters of this variety (see Figure 6). In length they approach that of the primary florets of such varieties as DeSoto, Lee, Arlington, and Mustang and are usually more plump.

The seeds of tertiary florets, while fairly common, are not borne in sufficient abundance to be characteristic of the variety.

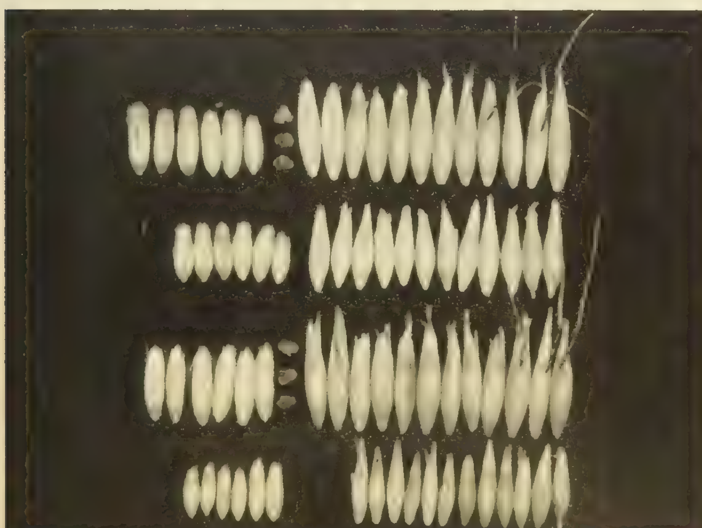

Fig. 6. The two upper rows are seed of Arkwin; the two lower rows are seed of Tennessee 1922, the mother parent. Note the relatively large size of the secondary florets of Arkwin in the second row from the top.

They are usually much smaller than those of the other two florets, although big enough not to be lost in well-regulated seed cleaning operations.

A commercial sample of seed, combine run, often averages 36 pounds to the bushel. Recleaned seed has averaged up to 42 pounds.

The amount of hull is relatively low among winter oats and has averaged 22 per cent compared with 25 per cent or more for most commercial varieties.

The dehulled kernel or groat has more hairs, especially along the suture, than such varieties as Traveler, Fulgrain, Victorgrain, Taggart, DeSoto, Stanton, Letoria, and Ferguson 922.

Plant Characters

As noted previously, the early growth is relatively large and upright or intermediate in habit. The color of this early growth as well as of mature plants is dark green, approaching a bluish green. It closely resembles Fulwin and is much deeper green than Traveler, Letoria, DeSoto, and the Red Rustproofs (see Figure 7).

Fig. 7. The dark green color of Arkwin can be seen in this photograph taken on March 22, 1951. The plot on the left is Nortex 107; the plot on the right, with the darker color, is Arkwin.

The height of mature plants in upland soils of medium fertility averages 40 to 44 inches. In fertile soils of the rice-growing region the height reaches 50 inches. The large straw may be disliked by those who prefer short-strawed varieties for combine harvesting, although agricultural engineers see no more difficulty in harvesting a tall-growing oat than a short one. Furthermore, the short-strawed varieties frequently have their panicles so bent downward at the time of combine harvesting that unless a pick-up reel is used, they drop to the ground on being cut and are not picked up by the combine. One of the advantages of Arkwin is that the large straw permits adjustment of the combine to such a height that certain weed seeds, such as those of "wild onion," would be largely missed in the harvesting operation.

The stems are relatively thick and strong, standing up well in the presence of strong winds (see Figure 8.) They keep the plants sufficiently upright to permit combine harvesting at full maturity when other varieties, notably most of the Red Rustproofs, may be badly lodged. Likewise, there is little or no shattering when the plants are sufficiently mature for combine operation.

The mature plant characters resemble those of Fulwin quite closely, the main differences being the absence of nodal hairs on

Fig. 8. This photograph was taken May 28, 1952, following a heavy wind storm. The unlodged rows at the right are Arkwin; the lodged rows are another variety.

Arkwin and the presence of such hairs around the two upper nodes of Fulwin, and the difference in foliage which is considerably longer, wider, and thicker in Arkwin. The panicles are similar, being of a spreading type in both varieties.

As to date of maturity, Arkwin is medium among winter oats, being usually a few days later than the earliest maturing varieties such as Fulgrain and Fulghum 708, and a few days earlier than Arlington, Atlantic, and most of the Red Rustproofs including Ferguson 922 and Nortex 107. At the Main Agricultural Experiment Station it usually matures about the same time as Victorgrain 48-93, Traveler, Letoria, Stanton, and DeSoto. Following a severe winter, it tends to mature a few days earlier than most of these varieties, presumably because of less winter injury.

SUMMARY

Arkwin represents a selection from the cross Tennessee 1922 X Bond-Iogold, the final selection being made in the F_{10} generation. The object in making this cross was to combine the exceptional winter hardiness of the former variety with the disease resistance and upright habit of growth of the latter. This appears to have been accomplished.

The genetics for resistance to crown rust in this Bond cross appears to be more complex than has been postulated.

Arkwin seemingly possesses a high degree of winter hardiness, about as much as Forkedeer or Fulwin.

Its grain yields at the Main Agricultural Experiment Station have been outstanding. At the Rice Branch Experiment Station the grain yields have not been exceptional although they were superior to Ferguson 922 and Nortex 107.

In forage value, Arkwin has led for three successive years at the Main Agricultural Experiment Station. Its rapidity of early growth, relatively large foliage, and upright growth habit, combined with much winter hardiness, seemingly make it an outstanding fall and winter pasture-type oat for Arkansas.

Data on protein content of fall and winter oat forage is presented, along with comparative data for other small grains. Such forage, grown on well managed upland soils of medium fertility, is relatively rich in proteins, particularly in the fall and early winter. There appears to be a reduction in amount of protein as the winter season advances.

Arkwin appears to combine one of the widest ranges of disease resistance now known including resistance to race 1 of crown rust and partial resistance to race 45 of this rust; partial resistance to race 7 of stem rust (but not races 6 or 8); resistance to current races of smuts; high resistance to Helminthosporium blight, and perhaps some resistance to Helminthosporium leaf spot and anthracnose; high resistance to virus diseases including yellow dwarf or barley false stripe and red spot mosaic, and possibly some resistance to soil-borne viruses. In the early stages of growth it appears to possess drought resistance as well as resistance to winter injury. It is not resistant to race 101 of crown rust.

Arkwin is particularly recommended for the hilly parts of the state as well as other parts where fall and winter pasture is needed. However, it is not recommended to the exclusion of other recommended varieties.

Details of the botanical and agronomic characters are presented including its relationship to the red oat group, its relatively large plump seed averaging 36 pounds per bushel combine run, its relatively small percentage of hull, its relatively good straw which permits combine harvesting, and its medium date of maturity.

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Recommendations on seeding and growing oats in Arkansas are given in a leaflet of the Arkansas Agricultural Extension Service. Copies can be obtained from county Extension agents.